Claims

I claim:

1. A rotorcraft which provides controlled flight in all six degrees of freedom, comprising:

a fuselage;

at least two rotor blade assemblies rotatably mounted to said fuselage about a vertically disposed central axis, each rotor blade assembly having a plurality of radially-extending airfoil shaped blades adapted to produce variable vertical and horizontal thrust components during operation;

a rotor drive system mounted to said fuselage and including a power device adapted for rotationally driving said rotor blade assemblies in opposite rotational directions;

a rotor blade control system operatively connected to said blades adapted to control said vertical and horizontal thrust components of said blades of said rotor blade assemblies including a controller adapted to monitor the rotational location of each blade relative to said fuselage and input signals indicative of required vertical and horizontal thrust components of each blade to blade control devices adapted to change said vertical and horizontal thrust components of said blades throughout each revolution of each blade about said fuselage; and

a flight control input device operable by a pilot of the rotorcraft adapted to input desired changes in direction, altitude, and attitude of the rotorcraft to said controller of what maneuvers are desired by the pilot, whereby said input signals from said controller to said rotor blade control system include adjustments to said vertical and horizontal thrust components of each blade to execute said desired maneuvers of the rotorcraft.

2. The rotorcraft of Claim 1, wherein the blades are pivotable about respective longitudinal axes to adjust a pitch angle thereof relative to a rotational plane of the rotor blade assembly to control the vertical and horizontal thrust components of each blade.

3. The rotorcraft of Claim 1, wherein the blades include respective flaps pivotally mounted thereto each adapted to adjust an effective pitch angle of said blades relative to a rotational plane of the rotor blade assembly to control the vertical and horizontal thrust components of each blade.

4. The rotorcraft of Claim 3, wherein the flaps are pivotally mounted at respective trailing edges of the blades.

5. The rotorcraft of Claim 4, wherein the flaps are pivotally mounted at the trailing edges of the blades disposed within respective flap slots.

6. The rotorcraft of Claim 1, wherein each rotor blade assembly includes a blade support ring to which the blades are mounted extending radially outwardly therefrom, said support rings being rotatably mounted to the fuselage by a rotor support assembly.

7. The rotorcraft of Claim 6, wherein the rotor blade assemblies are in pairs of counter-rotating rotor blade assemblies driven to rotate in the opposite rotational directions disposed in respective parallel rotational planes.

8. The rotorcraft of Claim 7, wherein the pairs of counter-rotating rotor blade assemblies have equal numbers of blades.

9. The rotorcraft of Claim 7, wherein the pairs of counter-rotating rotor blade assemblies are driven to rotate in opposite rotational directions at substantially the same rotational speed.

10. The rotorcraft of Claim 9, wherein the blade support rings of each pair of counter-rotating rotor blade assemblies comprise respective upper and lower rings, said upper ring having an annular lower surface and said lower ring having an annular upper surface which faces said annular lower surface, said annular upper and lower surfaces being simultaneously engaged by respective outer peripheries of a plurality of vertical spacer wheels disposed therebetween which are operably connected to the fuselage, at least one of said vertical spacer wheels comprising a vertical drive wheel adapted to be driven by the power device to drive said upper and lower rings in opposite rotational directions.

11. The rotorcraft of Claim 10, wherein the upper and lower rings comprise respective upper and lower gear rings, the lower surface of said upper gear ring comprising an annular toothed lower surface and the upper surface of said lower gear ring comprising an annular toothed upper surface, the vertical spacer wheels comprise respective externally toothed vertical spacer gears, and the vertical drive wheel comprises an externally toothed vertical drive gear, said annular upper and lower toothed surfaces being simultaneously engaged by said vertical spacer gears and said vertical drive gear to positively drive said upper and lower gear rings in the opposite rotational directions.

12. The rotorcraft of Claim 10, wherein the upper and lower rings of each pair of counter-rotating rotor blade assemblies includes both an upper and a lower surface and at least one annular angled inner surface, said annular angled inner surfaces and said upper and lower surfaces which are not engaged by the spacer wheels and drive wheel being engaged by respective angled guide wheels which are operably connected to the fuselage to maintain said upper and lower rings in position supported by and rotating about the central axis of said fuselage.

13. The rotorcraft of Claim 12, wherein the upper and lower rings comprise respective upper and lower gear rings each of which includes both annular upper and lower surfaces and at least one annular angled inner surface, said upper and lower surfaces of said upper and lower gear rings comprise respective annular toothed upper and lower surfaces, the vertical guide wheels comprise respective externally toothed vertical guide gears, the vertical drive wheel comprises an externally toothed vertical drive gear, said annular upper and lower toothed surfaces being simultaneously engaged by said vertical guide gears and said vertical drive gear to positively drive said gear rings in the opposite rotational directions, the annular angled inner surfaces comprise annular toothed angled inner surfaces, and the angled guide wheels comprise respective externally toothed angled guide gears to positively engage said gear rings.

14. The rotorcraft of Claim 12, wherein the rotor support assembly includes a plurality ring gear supports affixed to the fuselage, each ring gear support adapted to rotationally support the spacer wheels, the drive wheel, and the guide wheels.

15. The rotorcraft of Claim 6, wherein each of the blades has a rotatable control shaft extending longitudinally inwardly therefrom rotationally connected to respective of the support rings adapted to control the vertical and horizontal thrust components of respective of said blades.

16. The rotorcraft of Claim 15, wherein the control devices are mounted to the fuselage inside of the support rings, and the rotor blade control system includes a non-rotating control ring for each gear ring, each of said control rings being disposed radially inwardly of an associated one of said gear rings and connected to the fuselage through at least three of said control devices spaced about a circumference thereof so as to be tiltable and vertically positionable by said control devices, the blades being operably slidably connected to respective of said control rings whereby respective tilt and vertical positioning of said control rings as set by pilot input through the controller and said control devices rotates respective of the control shafts of said blades to control the vertical and horizontal thrust components of respective of said blades during rotation of said rotor blade assemblies about said control rings.

17. The rotorcraft of Claim 16, wherein each control device has a rotary output shaft, an inner thrust control arm being associated with each of said control devices having an input end affixed to said rotary output shaft and an output end operatively connected to respective of the control rings through a coupling device, and the control shafts of said blades being operably slidably connected to respective of the control rings using respective outer thrust control arms each having an input end attached through a slide device to respective of said control rings, and an output end

affixed to respective of said control shafts for causing rotation thereof to control the vertical and horizontal thrust components of respective of said blades.

18. The rotorcraft of Claim 15, wherein the control devices of the rotor blade control system are mounted to respective of the support rings for rotation therewith and operably connected to respective of the control shafts to control rotation of said control shafts.

19. The rotorcraft of Claim 18, wherein the control devices include respective electric servo-motors which are electrically interconnected with the controller through an electrical ring and brush arrangement.

20. The rotorcraft of Claim 18, wherein the control devices include respective electric servo-motors which are electrically interconnected with the controller through a wireless communication arrangement.

21. The rotorcraft of Claim 6, wherein the fuselage of a substantially circular shape as viewed from above and below, and the support rings are disposed at an outer periphery of said fuselage with substantially an entire length of said blades extending radially outwardly beyond said fuselage.

22. The rotorcraft of Claim 6, wherein the flight control input device comprises pilot operated controls located within the fuselage, said pilot operated controls including a control stick

and foot pedals adapted to allow control of the pitch angle of the blades, and a throttle lever adapted to allow control of power output from the primer mover to the rotor blade assemblies.

23. A rotor system for rotorcraft which provides controlled flight in all six degrees of freedom, comprising:

at least two rotor blade assemblies rotatably mountable to the rotorcraft about a vertically disposed central axis, each rotor blade assembly having a plurality of radially-extending airfoil shaped blades adapted to produce variable vertical and horizontal thrust components during operation;

a rotor drive system mounted to the rotorcraft and including a power device adapted for rotationally driving said rotor blade assemblies in opposite rotational directions;

a rotor blade control system operatively connected to said blades adapted to control said vertical and horizontal thrust components of said blades of said rotor blade assemblies including a controller adapted to monitor the rotational location of each blade relative to the rotorcraft and input signals indicative of required vertical and horizontal thrust components of each blade to blade control devices adapted to change said vertical and horizontal thrust components of said blades throughout each revolution of each blade about the rotorcraft; and

a flight control input device operable by a pilot of the rotorcraft adapted to input desired changes in direction, altitude, and attitude of the rotorcraft to said controller of what maneuvers are desired by the pilot, whereby said input signals from said controller to said rotor blade control system include adjustments to said vertical and horizontal thrust components of each blade to execute said desired maneuvers of the rotorcraft.

24. The rotor system of Claim 23, wherein the blades are pivotable about respective longitudinal axes to adjust a pitch angle thereof relative to a rotational plane of the rotor blade assembly to control the vertical and horizontal thrust components of each blade.

25. The rotor system of Claim 23, wherein the blades include respective flaps pivotally mounted thereto each adapted to adjust an effective pitch angle of said blades relative to a rotational plane of the rotor blade assembly to control the vertical and horizontal thrust components of each blade.

26. The rotor system of Claim 25, wherein the flaps are pivotally mounted at respective trailing edges of the blades.

27. A method for providing controlled flight for rotorcraft in all six degrees of freedom, comprising the steps of:

providing a rotorcraft having at least two rotor blade assemblies which are rotatable about a vertically disposed central axis, each rotor blade assembly having a plurality of radially-extending airfoil shaped blades of variable horizontal and vertical thrust components;

powering the rotor blade assemblies to rotate in opposite rotational directions to effect flight of the rotorcraft; and

controlling the horizontal and vertical thrust components of each blade throughout each revolution about the rotorcraft to execute desired maneuvers of the rotorcraft.

28. The method of Claim 27, wherein the step of controlling the horizontal and vertical thrust components includes monitoring respective rotational locations of each blade about the rotorcraft.

29. The method of Claim 27, wherein the step of controlling the horizontal and vertical thrust components is effected by varying respective pitch angles of the blades about respective longitudinal axes of the blades relative to a rotational plane of the rotor blade assembly.

30. The method of Claim 27, wherein the step of controlling the horizontal and vertical thrust components is effected by varying respective effective pitch angles of the blades by moving respective flaps pivotally mounted to the blades disposed generally parallel to respective longitudinal axes of the blades relative to a rotational plane of the rotor blade assembly.